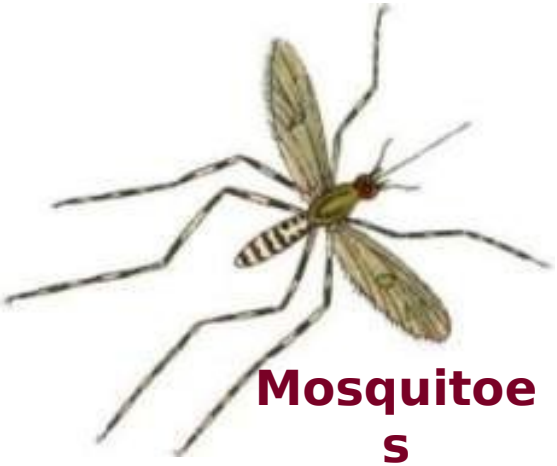
Vectors and Disease

WHY DOES THE VECTOR MATTER?



Mosquitoes

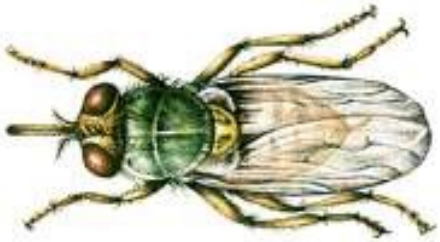
Ticks

Sand flies

Fleas

Chigger Mites

Lice



Tsetses

LTC Jennifer Caci

US Army Special Operations Command

Why does the vector matter?

It’s not just about disease…

Outline

- Threats
  - What does “vector-borne” mean?
  - Understanding vector-borne disease epidemiology
  - Area specific, risk assessment
  - What are the threats?
- Resources
  - Where can you find answers?
- Prevention
  - What can you do to minimize risk?

What is a vector?

- An arthropod that becomes infected with a pathogen and is able to transmit it to another host.
- Although an arthropod is able to maintain a parasite alive within its body, transmission depends upon its competence as a vector.

What are the **priority threats?**

It always depends but, in general according to "the experts"…

DEPARTMENT OF THE ARMY
BROOKE ARMY MEDICAL CENTER
3851 ROGER BROOKE DRIVE
FORT SAM HOUSTON TX 78234-6200

REPLY TO
ATTENTION OF
MCHE-MDI

23 April 2010

MEMORANDUM FOR RECORD

SUBJECT: Infectious Disease Threats to the US Military Prioritization Panel Results

1. A panel was hosted by the Directorate of Combat and Doctrine Development (DCDD) and the Military Infectious Diseases Research Program (MIDRP), US Army Medical Research and Materiel Command (MRMC), under the umbrella of the Medical Force Protection Integrated Capabilities Development Team (ICDT) Charter to prioritize the current infectious disease threats to the US Military (Appendix A).

2. Panel objectives were to identify and operationally prioritize the infectious disease threats to US Forces to assist in the determination of capability requirements.

3. References included "Initial Capabilities Document (ICD) for Infectious Disease Countermeasures (IDCM)," 2006, and "Infectious Diseases Investment Decision Evaluation Algorithm: A Quantitative Algorithm for Prioritization of Naturally Occurring Infectious Disease Threats to the U.S. Military," *Military Medicine* 2008;173:174-181.

Appendix A
Prioritization of Infectious Disease Threats to the US Military

1.	Malaria
2.	Dengue
3.	Diarrhea, bacterial
4.	Multidrug-resistant (MDR) wound pathogens
5.	Leishmaniasis
6.	Q fever (*Coxiella burnetti*)
7.	Norovirus and other viral diarrhea
8.	Influenza
9.	Adenovirus
10.	Leptospirosis
11.	Diarrhea, protozoal
12.	Tuberculosis (TB)
13.	Crimean-Congo hemorrhagic fever
14.	Human immunodeficiency virus (HIV/AIDS)
15.	Hemorrhagic fever with renal syndrome (HFRS)
16.	Chikungunya
17.	Meningococcal meningitis
18.	Plague
19.	Rickettsioses
20.	Viral encephalitides
21.	Hepatitis E
22.	Lassa fever and other arenaviruses
23.	Tick-borne encephalitis
24.	Rift Valley fever
25.	Hepatitis C
26.	Brucellosis
27.	Other arboviral illnesses
28.	Typhoid fever
29.	Cholera
30.	Schistosomiasis
31.	Tularemia
32.	Trypanosomiasis
33.	Ebola/Marburg hemorrhagic fever
34.	Chagas' disease
35.	Yellow fever
36.	Lyme
37.	Bartonelloisis (Oroya fever)
38.	Soil-transmitted helminths

PRIORITY THREATS

1. Malaria

2. Dengue

4. Leishmaniasis

13. CCHF

16. Chikungunya

18. Plague

19. Rickettsioses

20. Viral enceph

23. TBE

24. Rift Valley fever

27. Other arboviruses

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Vectorborne Disease Threats

TABLE I. Past and present impact of vector-borne diseases of military importance among deployed troops

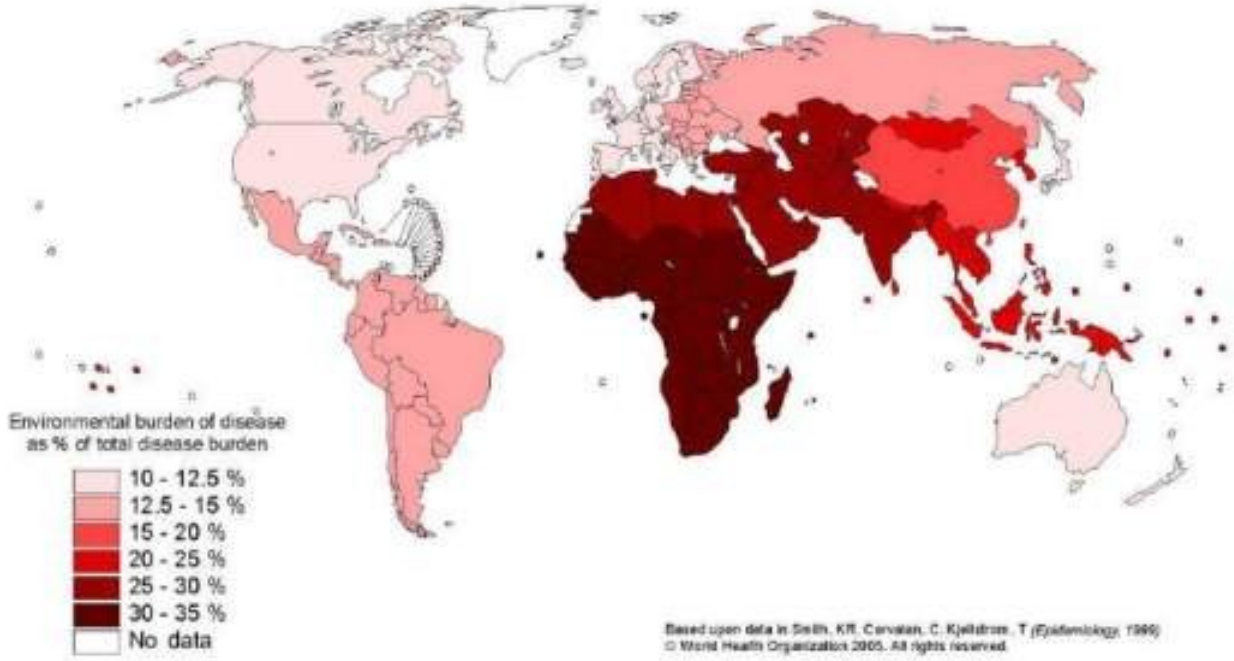
	Past threats		Present threats	Other diseases of less importance
Sandfly-borne diseases	Sandfly fever	★	Sandfly fever	Oroya fever
	Old World cutaneous leishmaniasis	★	Old World cutaneous leishmaniasis	
	New World mucocutaneous leishmaniasis	★	New World mucocutaneous leishmaniasis	
	Visceral leishmaniasis	★	Visceral leishmaniasis	
Mosquito-borne diseases	Malaria	★	Malaria	O'nyong nyong virus, Semliki Forest virus, Sindbi virus, and other mosquito-borne viruses
	Lymphatic filariasis	★	Dengue fever	
	Yellow fever	★	Chikungunya disease	
	Japanese B encephalitis		Rift Valley fever virus	
	Dengue fever	★	West Nile virus	
	Chikungunya disease			
Flea-borne diseases	Plague		Plague?	Flea-borne spotted fever
	Murine typhus		Murine typhus?	
Louse-borne diseases	Typhus			
	Trench fever			
	Louse-borne relapsing fever			
Tick-borne diseases	Rocky mountain spotted fever	★	Rocky mountain spotted fever	New pathogenic rickettsiae (*Rickettsia slovaca*, *Rickettsia helvetica*, and *Rickettsia sibirica mongolitimonae*)
	Mediterranean spotted fever		Mediterranean spotted fever	
	African tick bite fever		African tick bite fever	
	Other common tick-borne spotted fevers	★	Other common tick-borne spotted fevers	'Rickettsia of unknown pathogenicity'
	Ehrlichiosis		Ehrlichiosis	Colorado tick fever
	Q-fever*	★	Q-fever*	Kemerovo tick fever
	Tularemia*		Tularemia*	Other tick-borne fevers (Dugbe or Banjha virus)
	Crimean–Congo hemorrhagic fever	★	Crimean–Congo hemorrhagic fever	Omsk hemorrhagic fever
	Tick-borne encephalitis			Kyasianur Forest disease
				Alkhurma virus hemorrhagic fever
				Human babesiosis
Mite-borne diseases	Scrub typhus		Scrub typhus	
Tsetse fly-borne diseases	Sleeping sickness		Sleeping sickness	
Kissing bug-borne diseases	Chagas disease	★	Chagas disease	

Pages et al., 2010. The past and present threat of vector-borne diseases in deployed

Risk

What are the threats in my AO?

Depends on **where** you are and **when** you are there.



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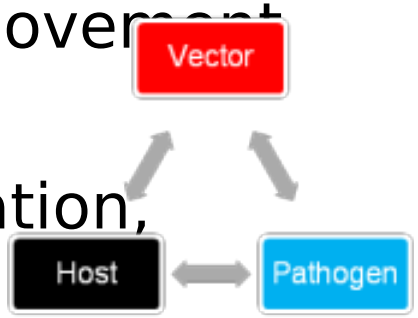
Components of transmission

- **Pathogen**
  - Imported genotypes, mutations, replication rate
- **Vector**
  - Feeding behavior, host preference, habitat, vector competence, density, life span .
- **Host and reservoir populations**
  - Immunity, density, living conditions, movement
- **Landscape/Ecology**
  - Climate, rainfall, temp, humidity, elevation, habitat

Iraq 2003-04



Where can you break the cycle?

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FACTORS TO HELP ESTIMATE RISK

1. What pathogens and strains/species are present?
   (*P. falciparum is far more serious than P. vivax)*

2. Will the mission put personnel into close contact with vectors?

- VECTOR BEHAVIOR
  - *Anopheles* mosquitoes are nighttime biters.
  - *Aedes* mosquitoes are daytime biters.
  - Sandflies typically fly close to the ground.
- VECTOR HABITAT…Will personnel operate in areas with vectors?
- BILLETING…in buildings with doors and screened windows?

3. Will conditions support disease transmission?

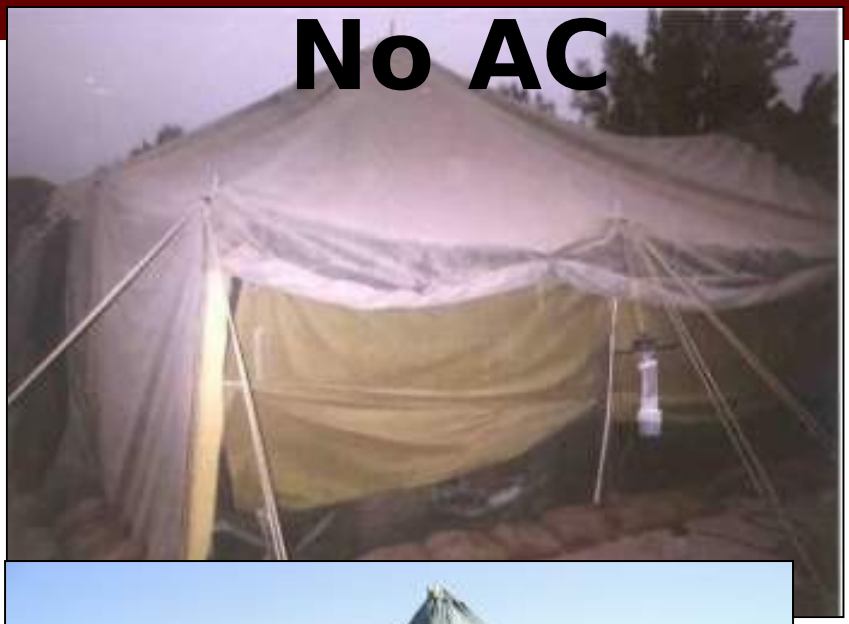
- SEASONALITY
- RECENT WEATHER (rain and mosquitoes, wind and sand flies)
- DENSITY OF VECTOR
- INFECTION RATE

4. What is the Incubation Period?

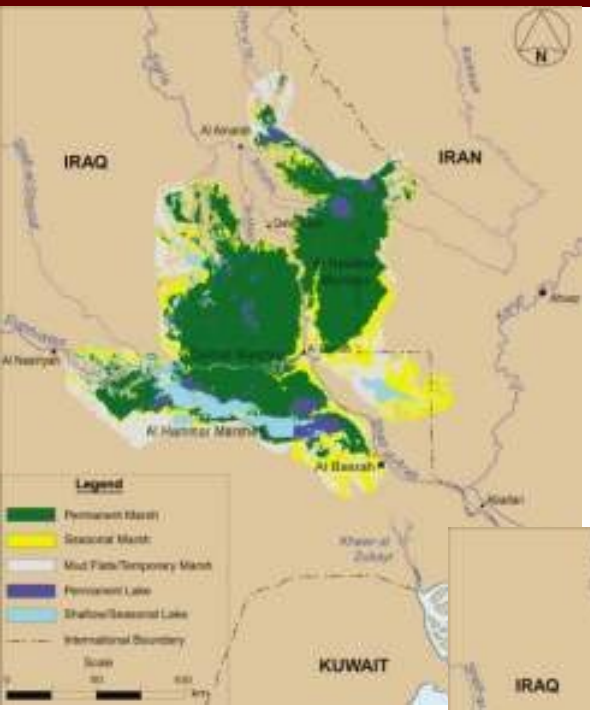
- IMMEDIATE VS. DELAYED IMPACT

Air Force Tent City

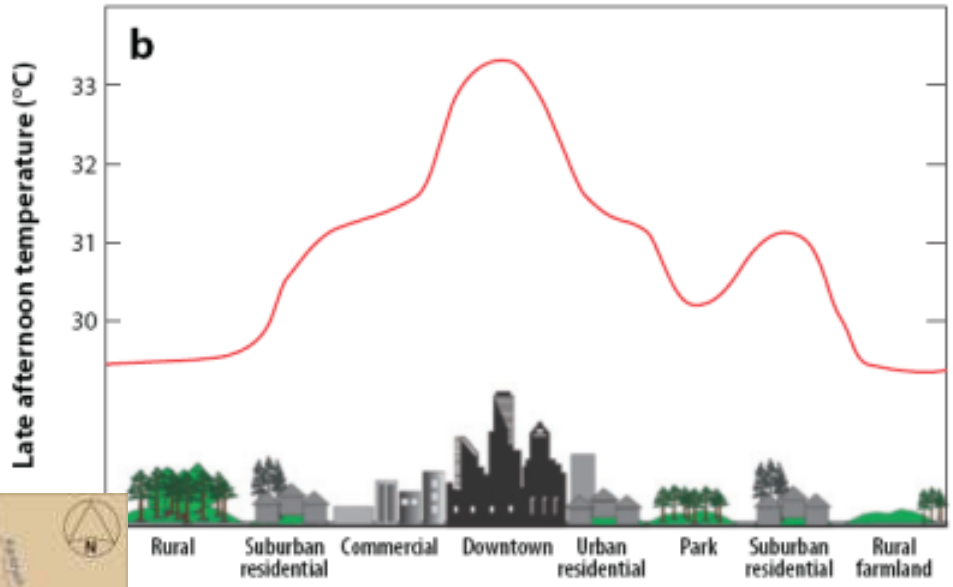
Army Tent City



Ecological Influence- Iraq Example



Water (rainfall, marshes etc)



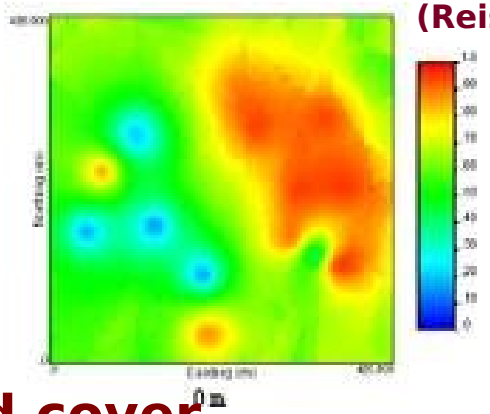
(Reisen, 2010)

1973

Malaria

Leish

2000



Land cover and Temperatu

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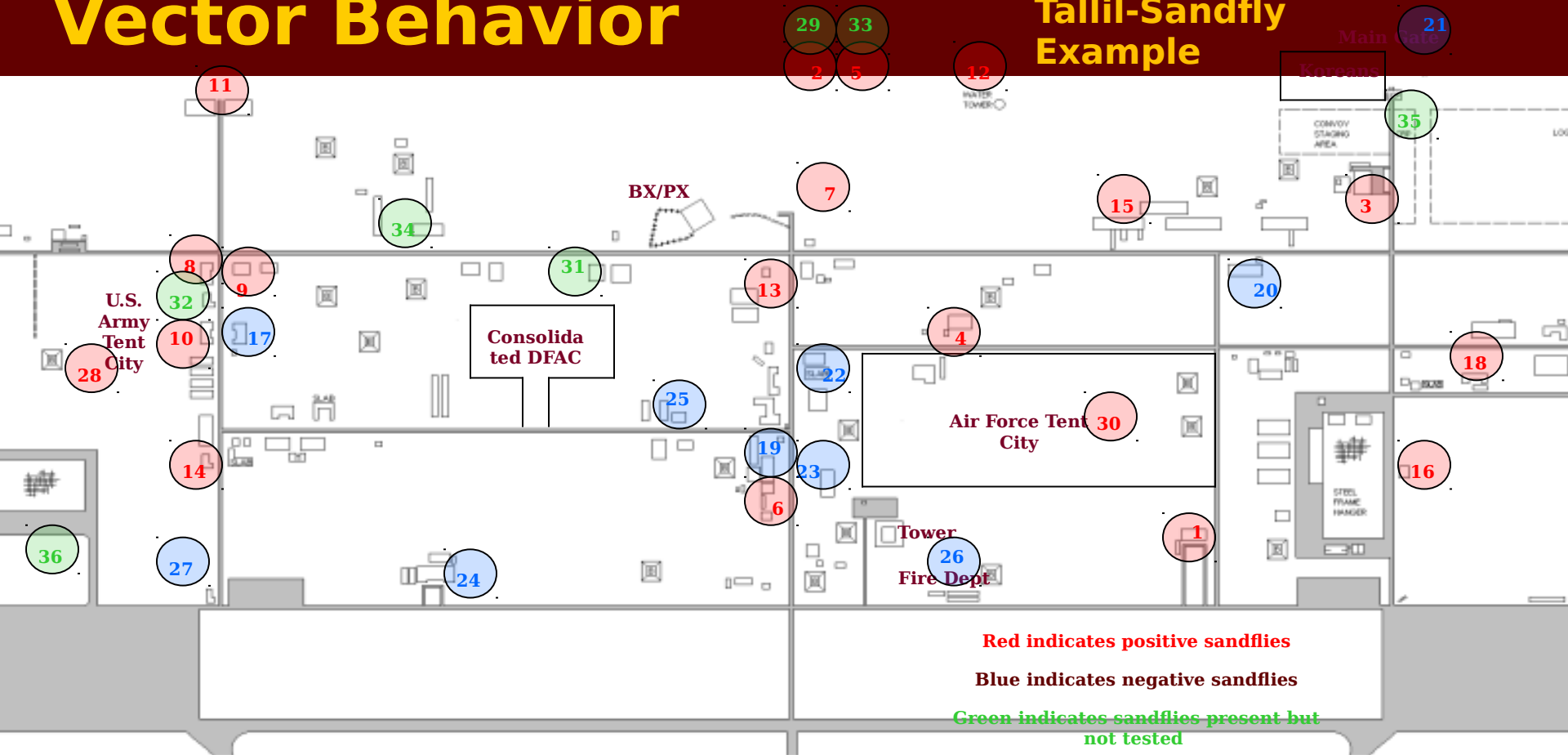
Vector Behavior

Tallil-Sandfly Example



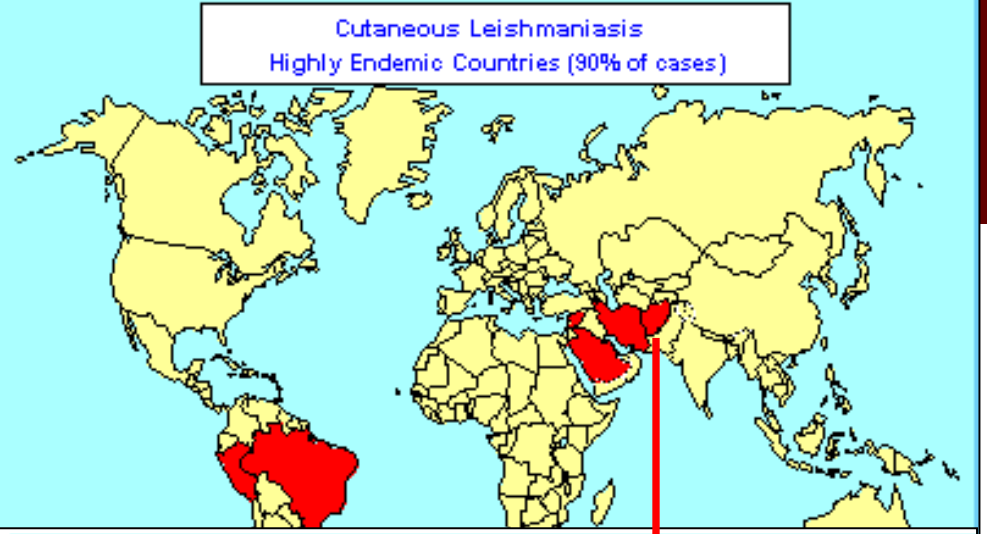
Location	tested	collected	infected	
1. AF-407th AEG TOC	510	131	2.29%	
2. Control Site 3	2,803	612	0.65%	
3. 1/293rd INF, HHD	30	21	4.76%	
4. AF – Post Office	351	74	4.05%	
5. Control Site 4	5,104	803	1.49%	
6. 171st ASG	1,180			

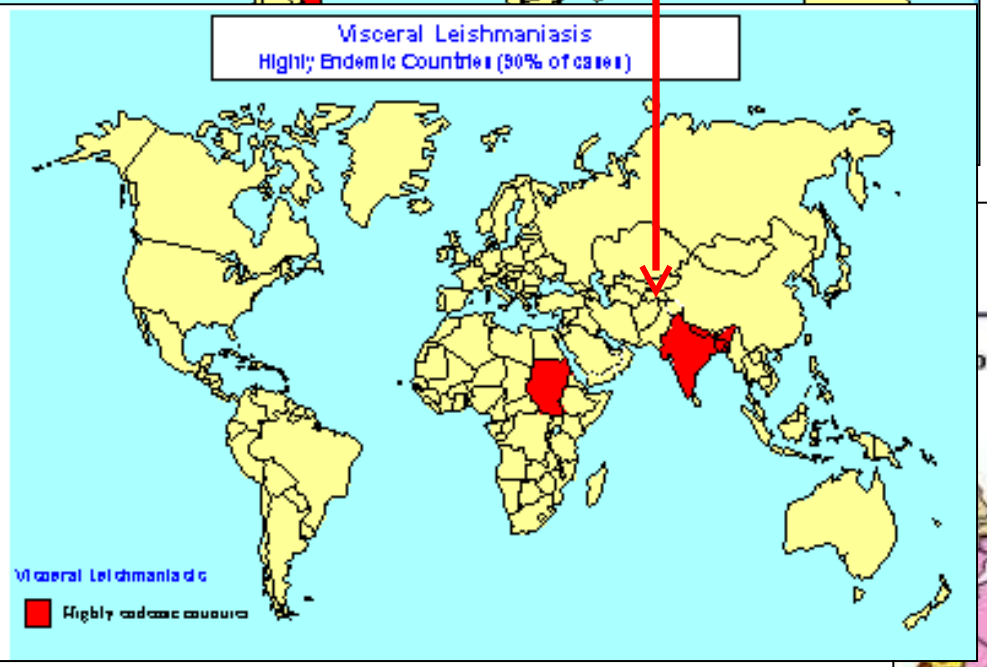
Location	tested	collected	infected	
10. Mosque	131	89	1.12%	
11. 2220th Trans	4,088	2,064	1.31%	
12. 1208th QM Co	16,280	3,128	0.90%	
13. Army Finance	3,217	478	0.21%	
14. 933rd MP Co HQ	749	115	1.74%	
15. 744th MP Bn	674	74		

Location	tested	collected	infected	
19. 486th CA Bn	108	52	0.00%	
20. V Corps IG	55	44	0.00%	
21. Airbase Entrance	53	28	0.00%	
22. Laundry/Bath	20	18	0.00%	
23. 63rd Sig Bde	14	11	0.00%	
24. 86th CSH	10	5		

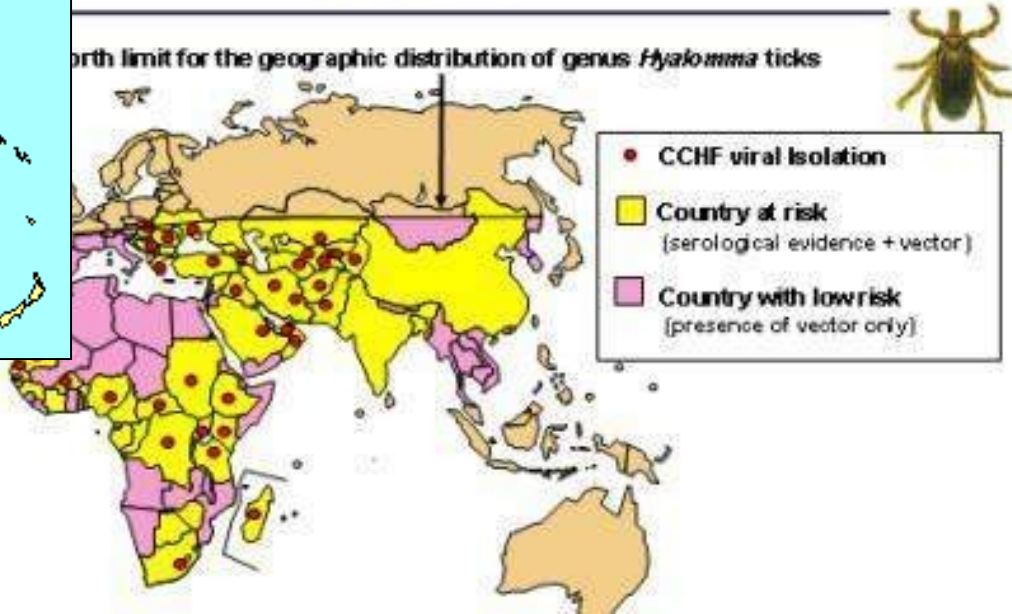
Location	tested	collected	infected	
28. Army Tent City	3,691	303	1.98%	
29. Control Site 1	1,087			
30. AF – Tent City	2,353	845	2.37%	
31. AF – 407th Maint	612			
32. S of 221st MI Bn	454			
33. Control Site 2	318			
34. AF-Security Force	268			
35. Convoy Center	230			

- Model of *P. falciparum*
- No transmission in areas surrounded by high transmission.
- Why?
- No vectors. The cycle was broken with appropriate pesticide use.





CCHF: geographic distribution



Or maybe no one is looking…

Help in Identifying Priority threats

- **Entomological Operational Risk Assessments (EORA)**

- Provide risk estimates for vector-borne and zoonotic diseases in the country of concern.

- These estimates, prepared by USACHPPM.

- EORAs available for >30 countries.

- **Infectious Disease Risk Assessment (IDRA)**

- AFMIC now NCMI

- Web-based and CD (MEDIC)

- unclassified medical intelligence

- **Disease Vector Ecology Profiles (DVEP)**
  http://www.afpmb.org/content/disease-vector-ecology-profiles

- **Geosentinel**
- **ProMed**

RESOURCES

Where can you find answers?

- Regional Public Health Command (PHC), Ento Div

http://chppm-www.apgea.army.mil/ento/default.htm

- AFPMB

http://www.afpmb.org

- NCMI (MEDIC CD)
- WRAIR Ento Div
- Walter Reed Biosystematics Unit (WRBU)

http://wrbu.si.edu and
http://mosquitomap.nhm.ku.edu/vectormap/

- Command PM assets

http://www.afpmb.org

Armed Forces Pest Management Board

recommends policy, provides guidance, and coordinates the exchange of information on all matters related to DoD pest management

Log in/Register

Search AFPMB.org

- Search the AFPMB Website

Questions?

- Send a question to the Board

DoD Topics

- Pesticide & Equipment Lists
- Training & Certification
- DoD Pesticide Hotline

Literature

AFPMB LRS | WRBU LRS

Hosted Sites

WRBU

NAVFAC

Military Entomology

Army | Navy | Air Force

Board Meeting Info

Next Board Meeting:
Oct. 31 - Nov 4, 2011

- Information from last meeting
- Board Minutes & Staff Reports
- Committee Workspaces

Contingency & Deployment Resources

We provide support to DoD personnel on any pest management issue in any situation. We also provide rapid accurate responses to questions regarding all aspects of pest management and maintain the website to meet the needs of our customers. Find a resource now

Literature Retrieval System

Our Literature Retrieval System is an online collection of scientific papers comprising over 100,000 documents in searchable PDF format, drawn from our extensive library of books, journals, reprints, reports, and other sources. Search our database of over 120,000 PDFs

Deployed War-Fighter Protection (DWFP) Program

The Deployed War-Fighter Protection research program (DWFP) is an initiative to develop and validate novel methods to protect United States Military deployed abroad from threats posed by disease-carrying insects. Read more

Disease Vector Ecology Profiles

Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates and plants that may adversely affect troops in specific countries or regions of the world. Read more

Technical Guides

As a unit of the AFPMB, ISD (Information Services Division) collects, stores and disseminates published and unpublished information on arthropod vectors and pests, natural resources, and environmental biology important to the DoD. Read more

Living Hazards Database

The Living Hazards Database (LHD) is a comprehensive compilation of more than 500 species worldwide, which are reported to cause serious injury or death of humans. Read more

What's New

- Audrey Perich and Brian Zeichner receive award for development of lethal ovitrap
- Report of the 5th Annual Meeting of the Roll Back Malaria Partnership
- Roll Back Malaria Progress & Impact Series
- Archives

Flickr Images

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REGIONAL RISK

DVEPS

- Provide risk estimates for vector-borne and zoonotic diseases in the regions of concern.
- Prepared by AFPMB.

Office of the Deputy Under Secretary of Defense for Installations & Environment

Regional Disease Vector Ecology Profile

South Central Asia

Defense Pest Management Information Analysis Center
Armed Forces Pest Management Board
Forest Glen Section
Walter Reed Army Medical Center
Washington, DC 20307-5001

Homepage: http://www.afpmb.org

September 2001

The Walter Reed Biosystematics Unit

HOME | VECTOR ID | WHO WE ARE | STAFF | WHAT WE DO | FAQS | FORUM

The Walter Reed Biosystematics Unit (WRBU) is a unique national resource. Its mission is to conduct systematics research on medically important arthropods and to maintain the U.S. mosquito collection. The WRBU is just one part of the U.S. Government's entomological research system, which includes the U.S. Department of Agriculture (USDA) and the Smithsonian Institution (SI). Historically, mosquito identification was managed by USDA and the SI, but in 1972 this responsibility was transferred from USDA to the U.S. Army for research on medically important arthropods. Located at the Museum Support Center of the Smithsonian Institution in Suitland, Maryland, the WRBU's physical space is provided by the Smithsonian Institution in return for curation of the collection and specimen identification... *(more)*

What's New?

Mosquito Classification 2010

Discussion Forum

New mosquito identification keys

See new WRBU staff publications

Vector Identification Resources

to medically important arthropods and WRBU's Vector Identification Service

VectorMap
MosquitoMap.org
SandflyMap.org
TickMap.org

Culicidae Catalog
www.mosquitocatalog.org

Mosquito Resources

Medically Important Mosquitoes

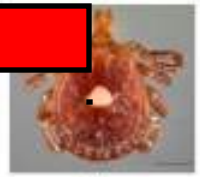
Mosquito Genera

Mosquito Species Identification Keys

Mosquito Literature

Other Vectors

Sand Flies



Ticks

Scorpions

Fleas

WRAIR Entomology

AFPMB

http://wrbu.si.edu/

VectorMap

- Comprised of MosquitoMap, SandflyMap and TickMap
- Geospatially referenced clearinghouses for arthropod disease vector species collection records and distribution models.
- Users can pan and zoom to anywhere in the world to view the locations of:
  - past **vector collections** and
  - the **results of modeling that predicts the geographic extent of individual species.**

http://mosquitomap.nhm.ku.edu/vectormap/

VectorMap is new and still in the test phase.

Requires you to download Silver Light freeware from Microsoft.

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Model of *Plasmodium falciparum* in 2005 from the Malaria Atlas Project

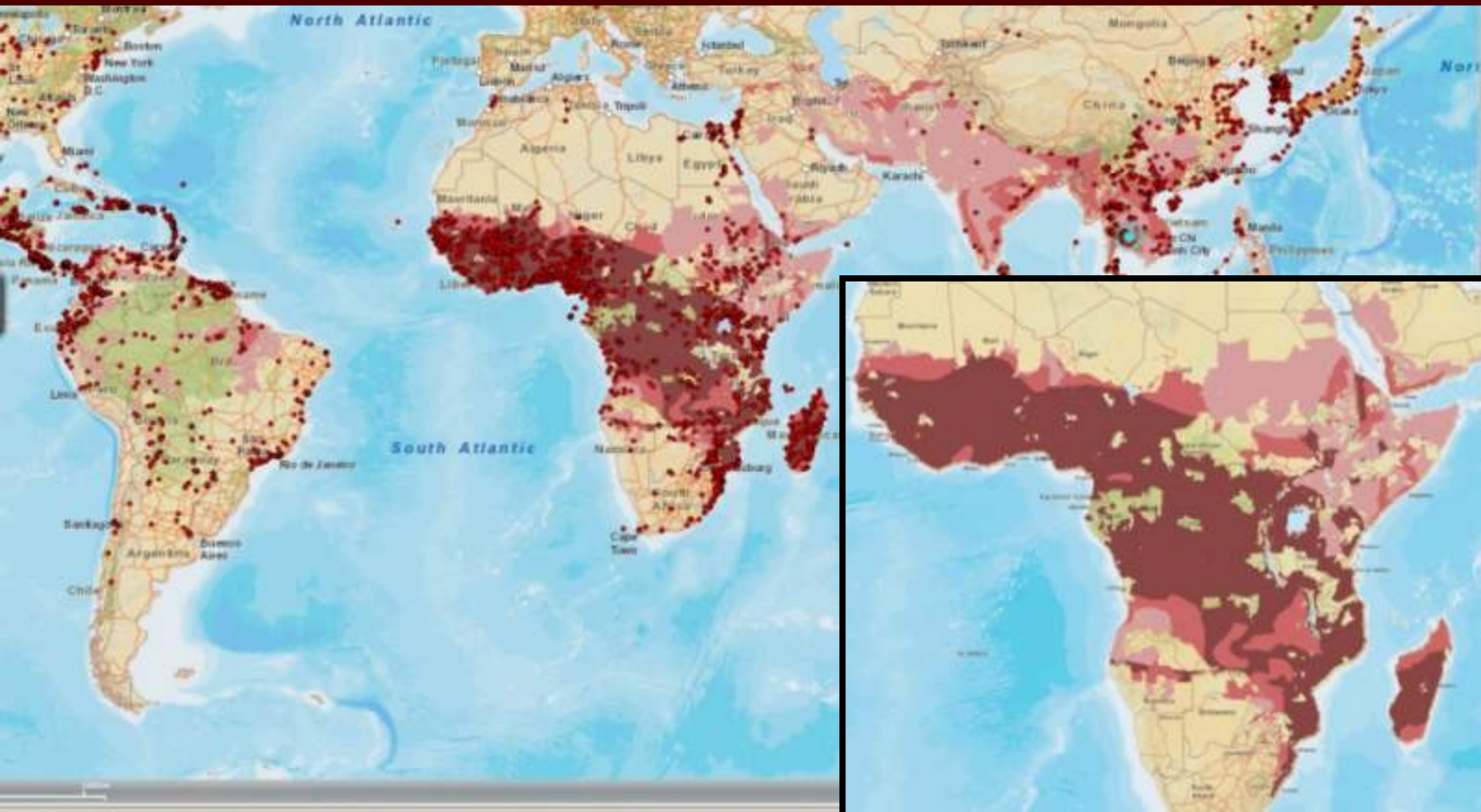
http://www.map.ox.ac.uk/index.htm.

Hypoendemic, Mesoendemic and Hyper-holoendemic

Several sources of information on malaria risk (notably international travel health guidelines on malaria chemoprophylaxis, altitude limits for dominant vectors, climate limits for malaria transmission and human population density thresholds) have been combined in a GIS to generate this map. See Guerra et al. (2006) Advances in Parasitology 62: 157 – 179 and Guerra et al. (2006) Trends in Parasitology 22: 353 – 358 for details.

The method for defining the endemic levels within these limits can be found in Snow et al. (2005) Nature 434: 214 – 217.

Anopheles collection records show up as red dots



Tick collection records

Major and Emerging Vectorborne Disease Threats

- Malaria
- Dengue
- Leishmaniasis
- Other arboviruses & the encephalitides
  - (e.g., chikungunya, JEV, WNV)
- Rickettsioses
  - (e.g. CCHF, African tick bite fever, scrub typhus)
- Trypanosomiasis (American & African)

What is a vector?

- An arthropod that becomes infected with a pathogen and is able to transmit it to another host.
- Although an arthropod is able to maintain a parasite alive within its body, transmission depends upon its competence as a vector.

Vector potential

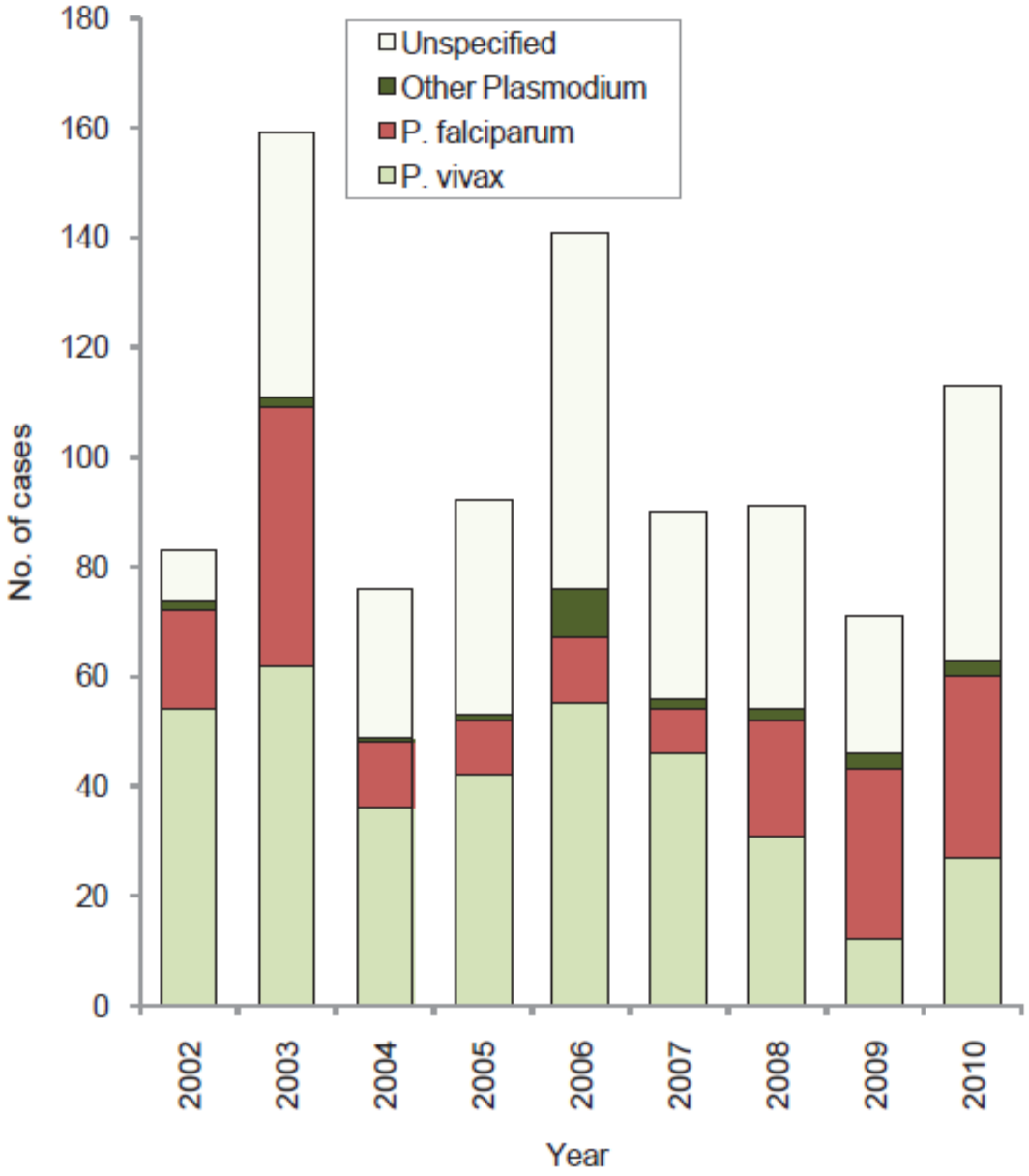
- Mosquito species vary in their vector potential because of environmental conditions and factors affecting their **abundance, blood-feeding behavior, survival, and ability to support parasite development (this all influences competence)**

- Sporogony is the complex life cycle of the malaria parasite in female mosquitoes.

- Most individual mosquitoes that ingest gametocytes from the reservoir or host do not support development to the sporozoite stage.

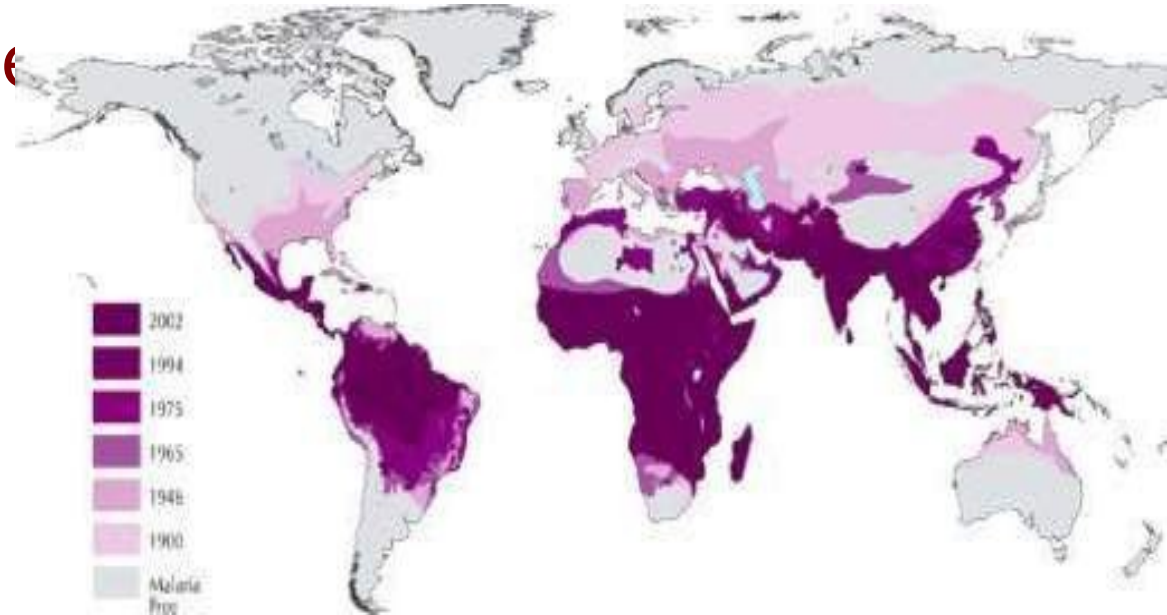
Malaria

Figure 1. Malaria cases among U.S. service members, by *Plasmodium* species and calendar year of diagnosis/report, 2002-2010



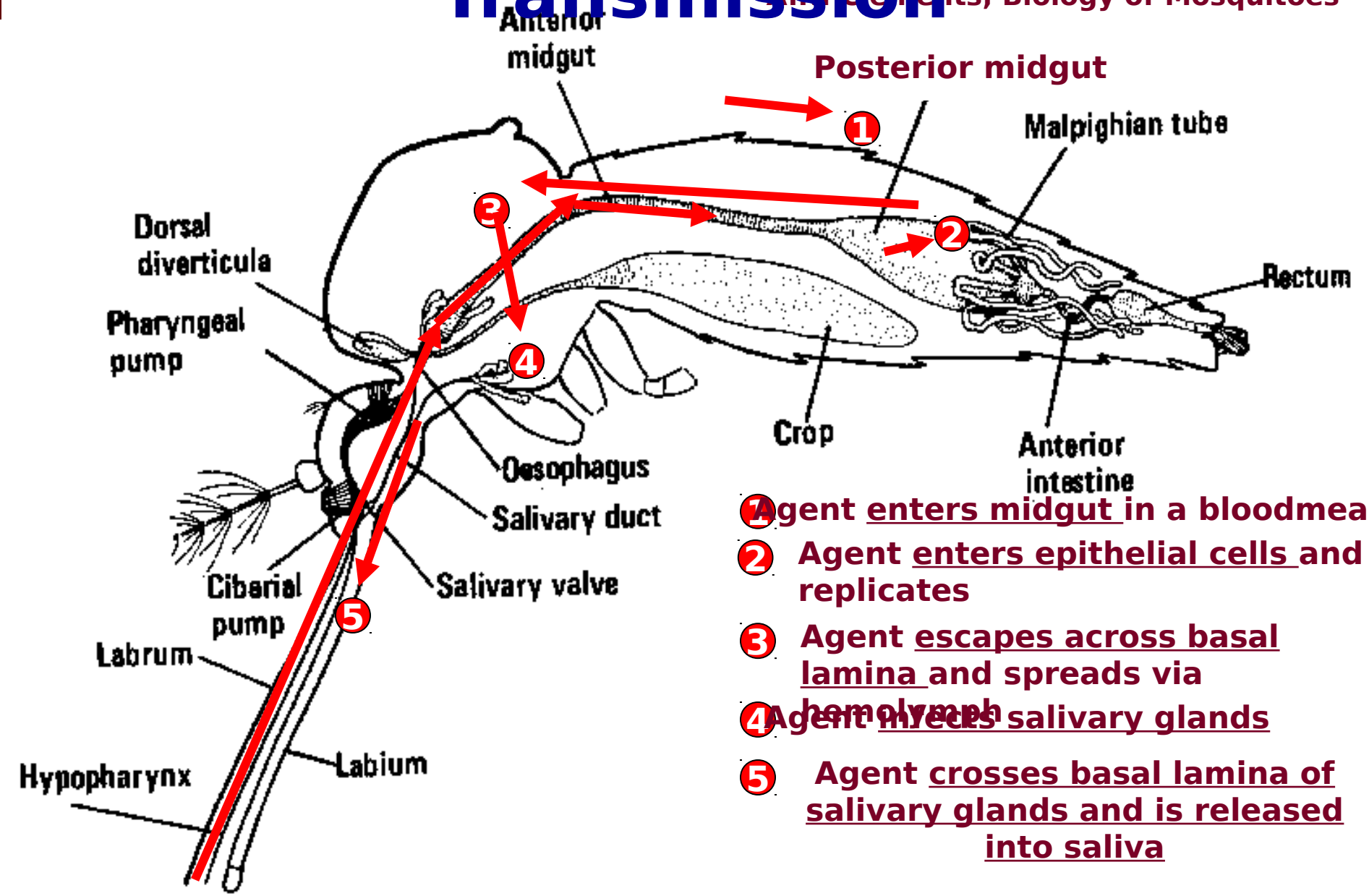
Malaria

- Risk varies geographically
  - Different species of Anopheles mosquitoes (varying competence).
- Entomological inoculation rate (EIR).
  - An estimate of exposure to infective mosquitoes,
  - EIRs can exce
    per night.

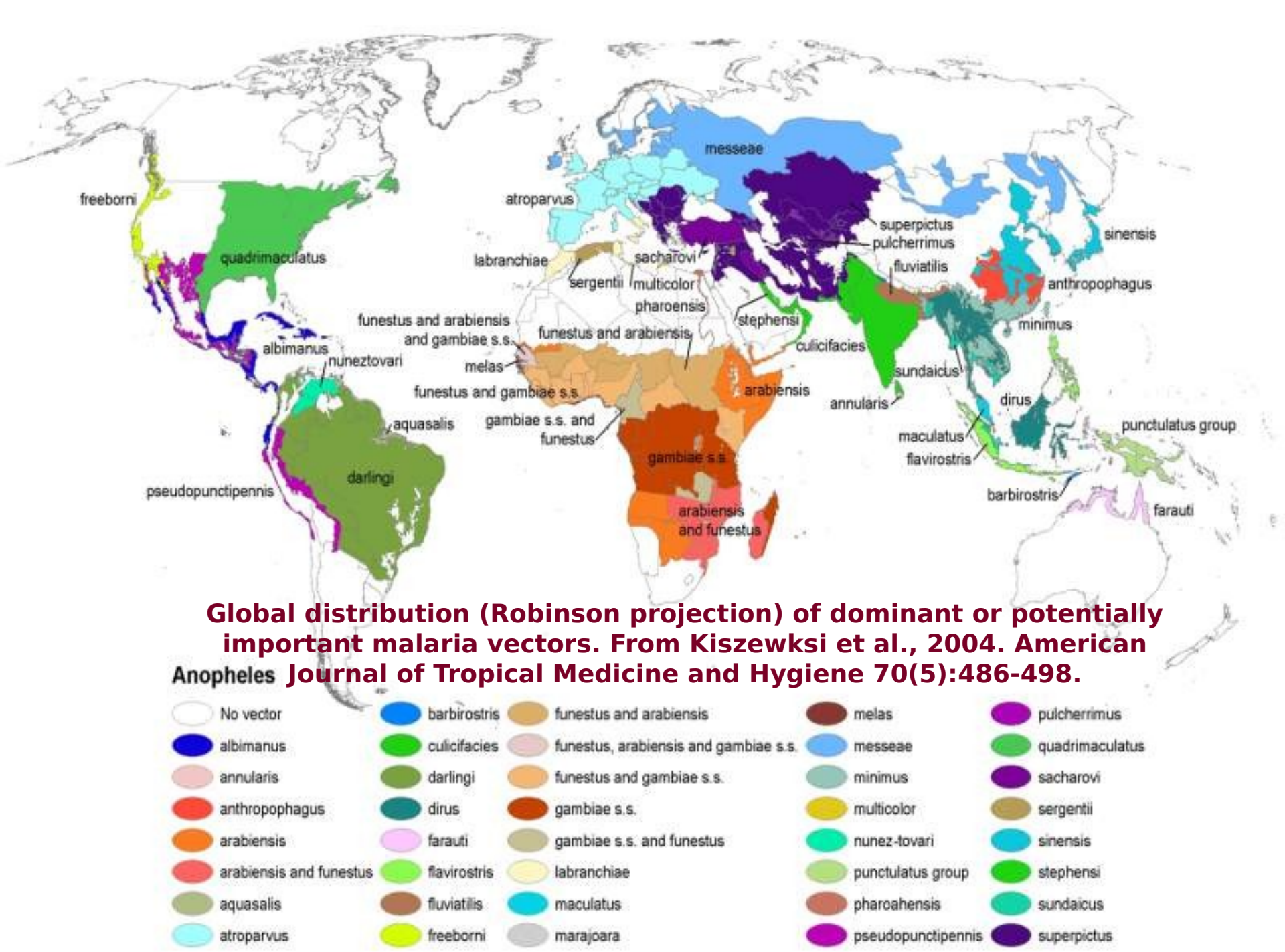


Barriers to Pathogen Transmission

A.T. Clements, Biology of Mosquitoes



1. Agent enters midgut in a bloodmeal
2. Agent enters epithelial cells and replicates
3. Agent escapes across basal lamina and spreads via hemolymph
4. Agent invades salivary glands
5. Agent crosses basal lamina of salivary glands and is released into saliva



Global distribution (Robinson projection) of dominant or potentially important malaria vectors. From Kiszewksi et al., 2004. American Journal of Tropical Medicine and Hygiene 70(5):486-498.

Biology of *Anopheles spp.*

Eggs

- Eggs are laid individually on the water surface and are kept afloat by air chambers (floats).
- Females lay batches of 75 to 150 eggs.
- The eggs hatch after two or three days at temperatures of 25-30ºC.
- At lower temperatures, this period can be longer, and the eggs can resist total or partial desiccation in moist soil for many days (up to years).

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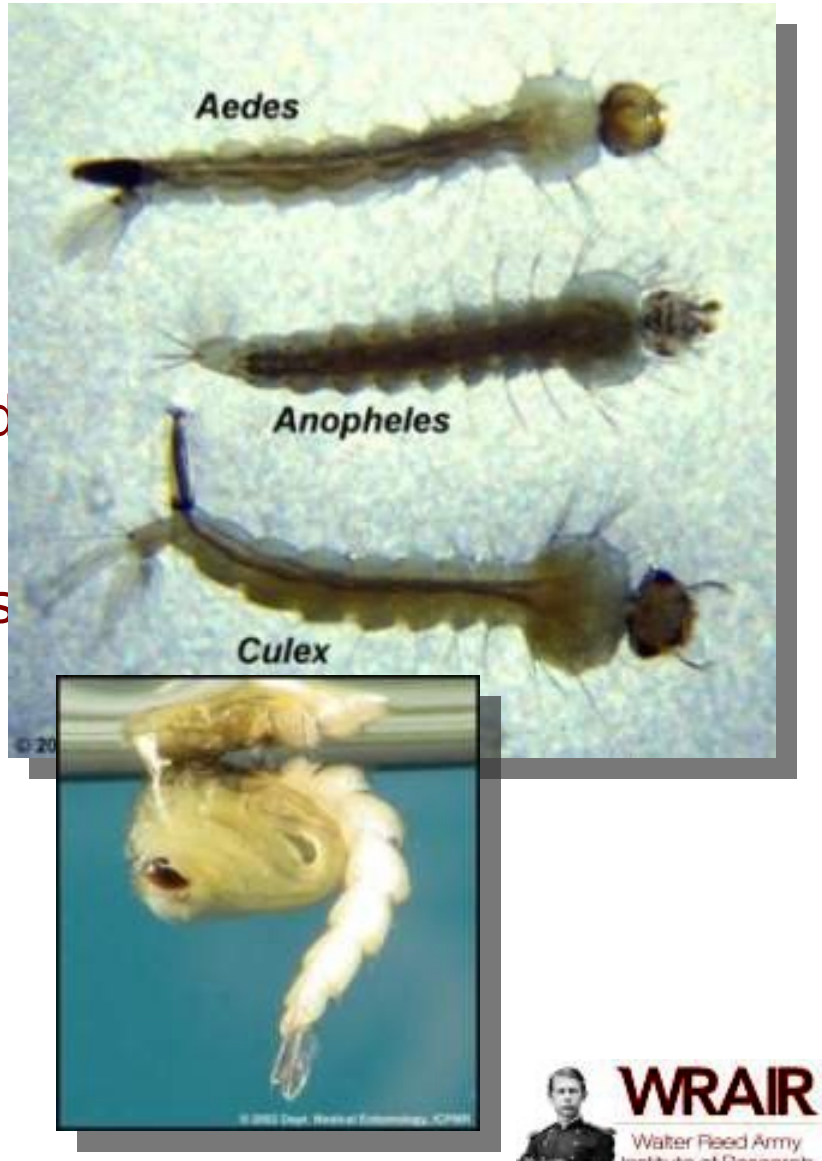
Biology of *Anopheles spp.*

Larvae

- Characteristic resting position, lying parallel to the water surface.
- Larval development takes around 5 to 7 days depending on temperature.
- Larval habitat varies with species



Pupae

- Pupae do not eat.
- Metamorphosis of the larva into an adult.
- It lasts from two to three days.

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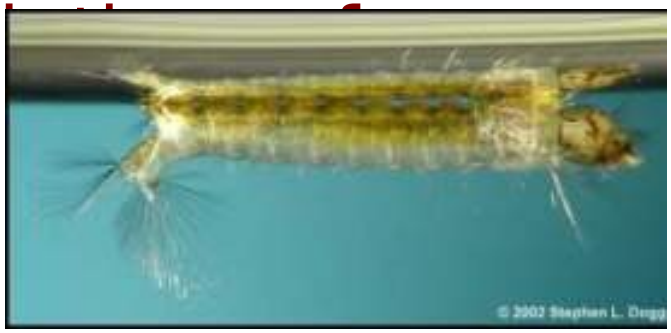
Biology of *Anopheles spp.*

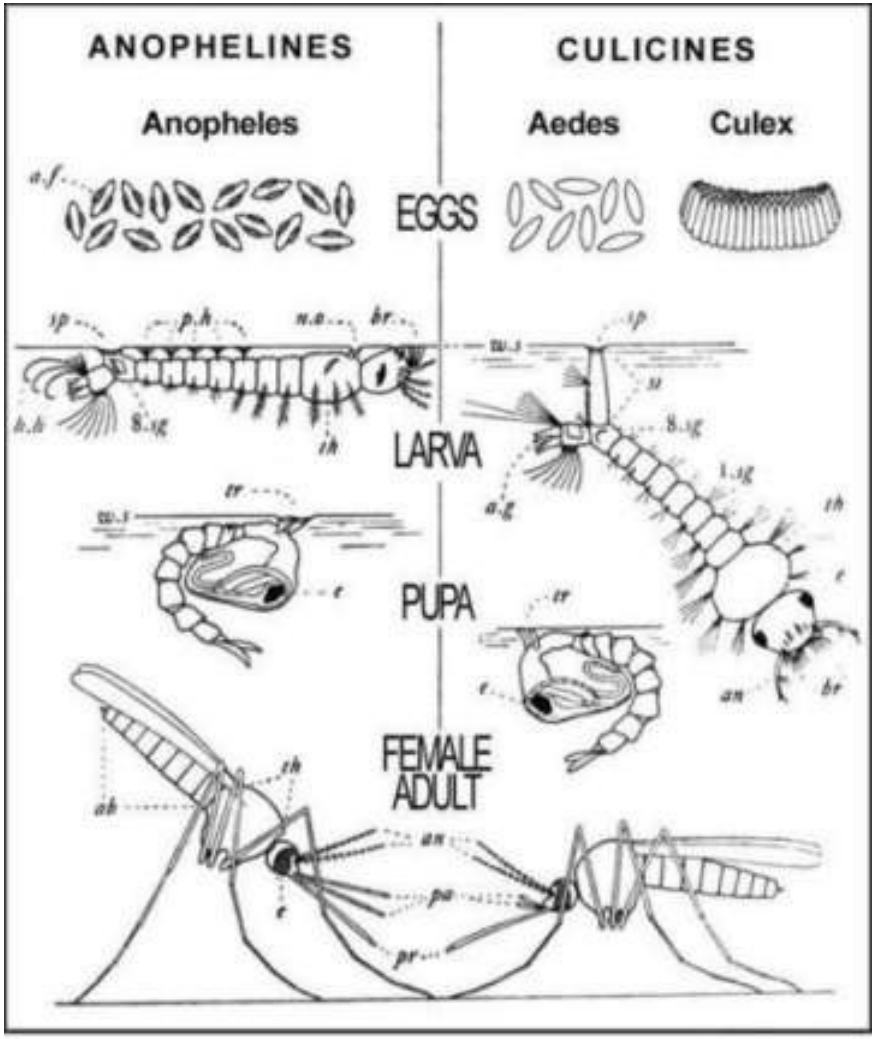
Adult:

- Live from 3 to 4 weeks although some can overwinter.
- Feeding occurs at night (dusk to dawn).
- Host preference varies by species.
- **Indoor vs. outdoor feeding**

Biology of *Anopheles spp.*

- Larvae lack a siphon
- Larvae rest parallel to water surface
- Adults hold body at an angle of 30º degrees or more wit





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Blood required for egg development

P. falciparum Transmission Cycle

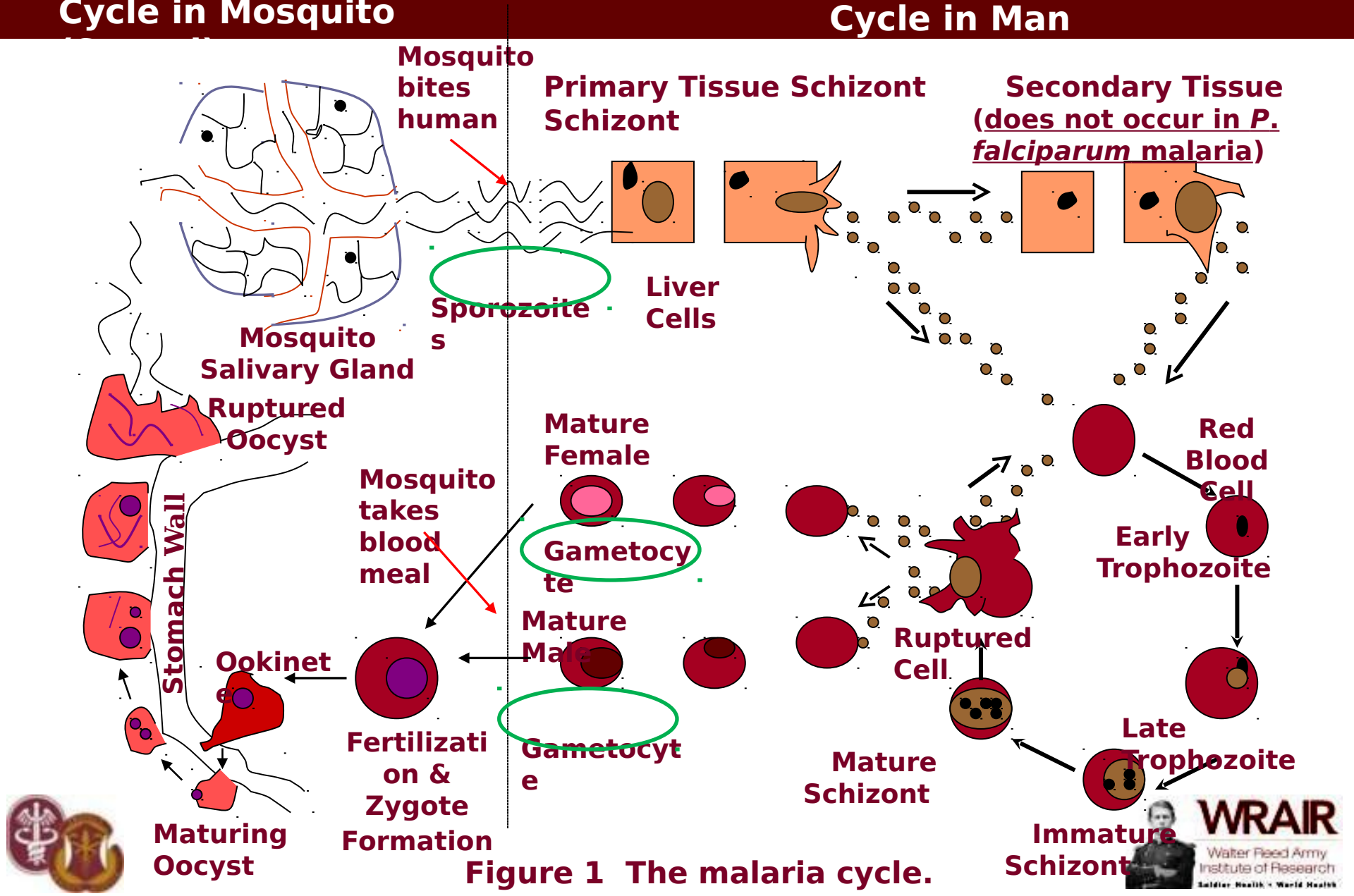
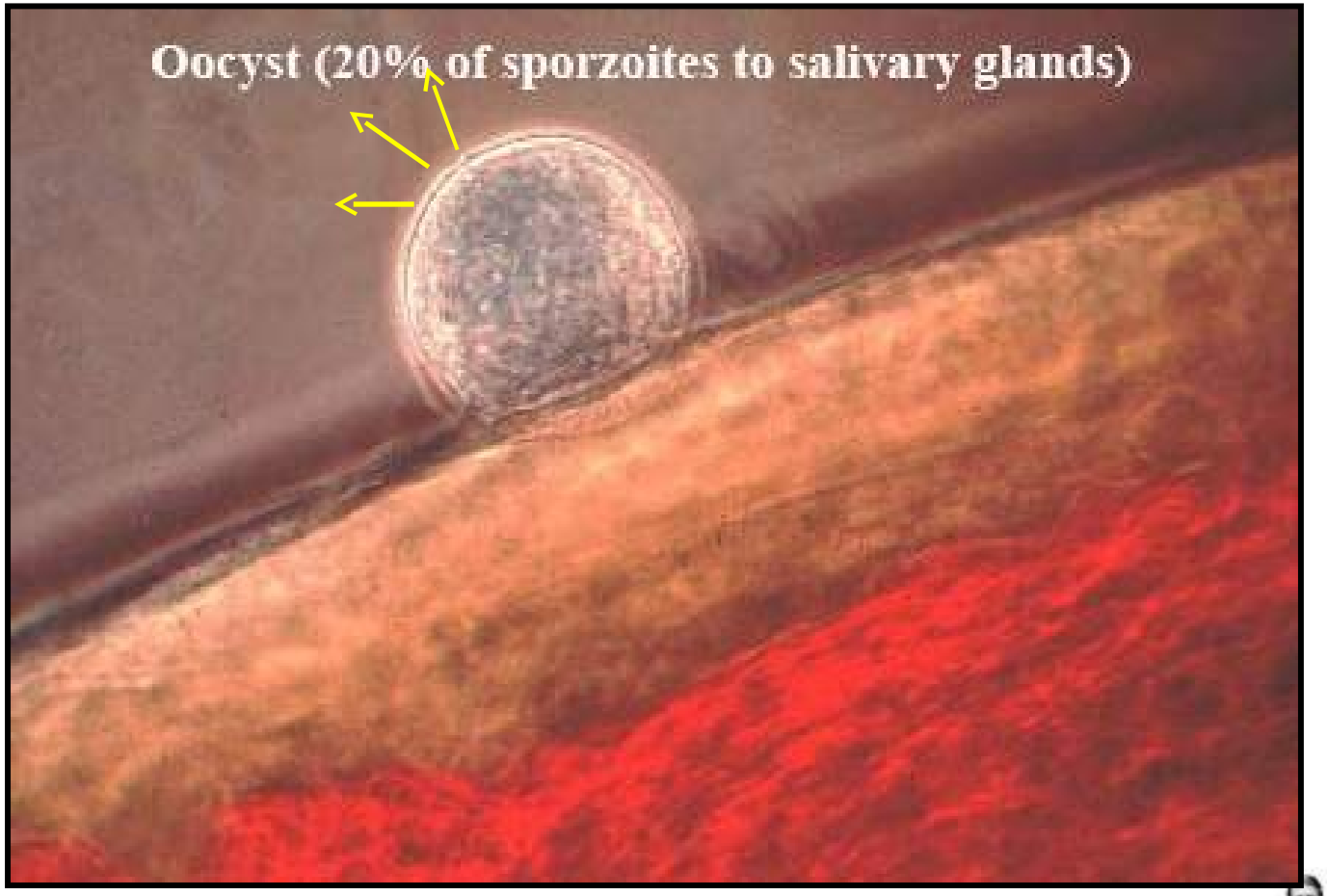
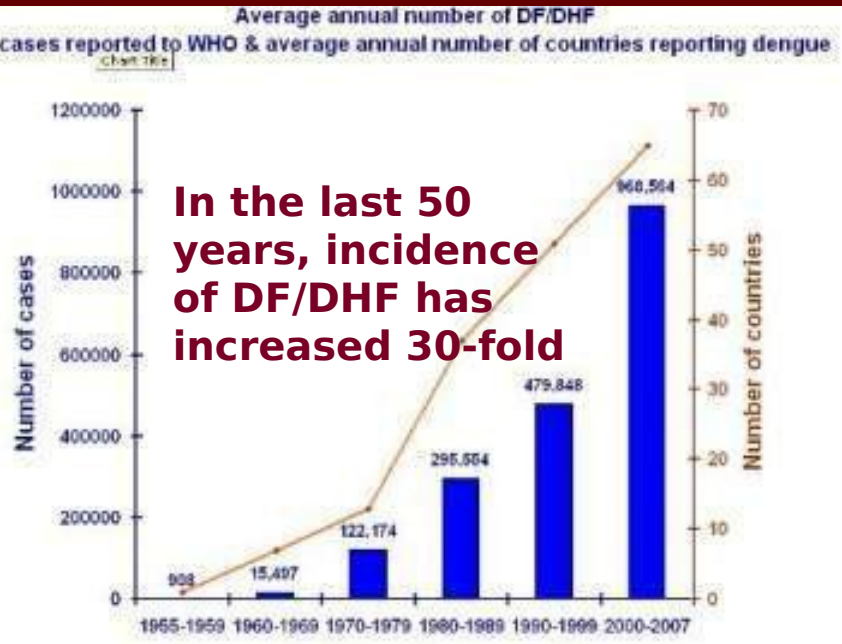


Figure 1 The malaria cycle.

Life cycle - Sexual stage



Dengue



In the last 50 years, incidence of DF/DHF has increased 30-fold

- **Endemicity has increased from 9 countries to over 100 countries since the 1970s**
- **The dengue transmission cycle occurs in the US**
- **No vaccine; treatment basically limited to supportive care**
- **Seroprevalence study; add to SRP?**

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Dengue virus vectors

Ae. albopictus

Ae. aegypti

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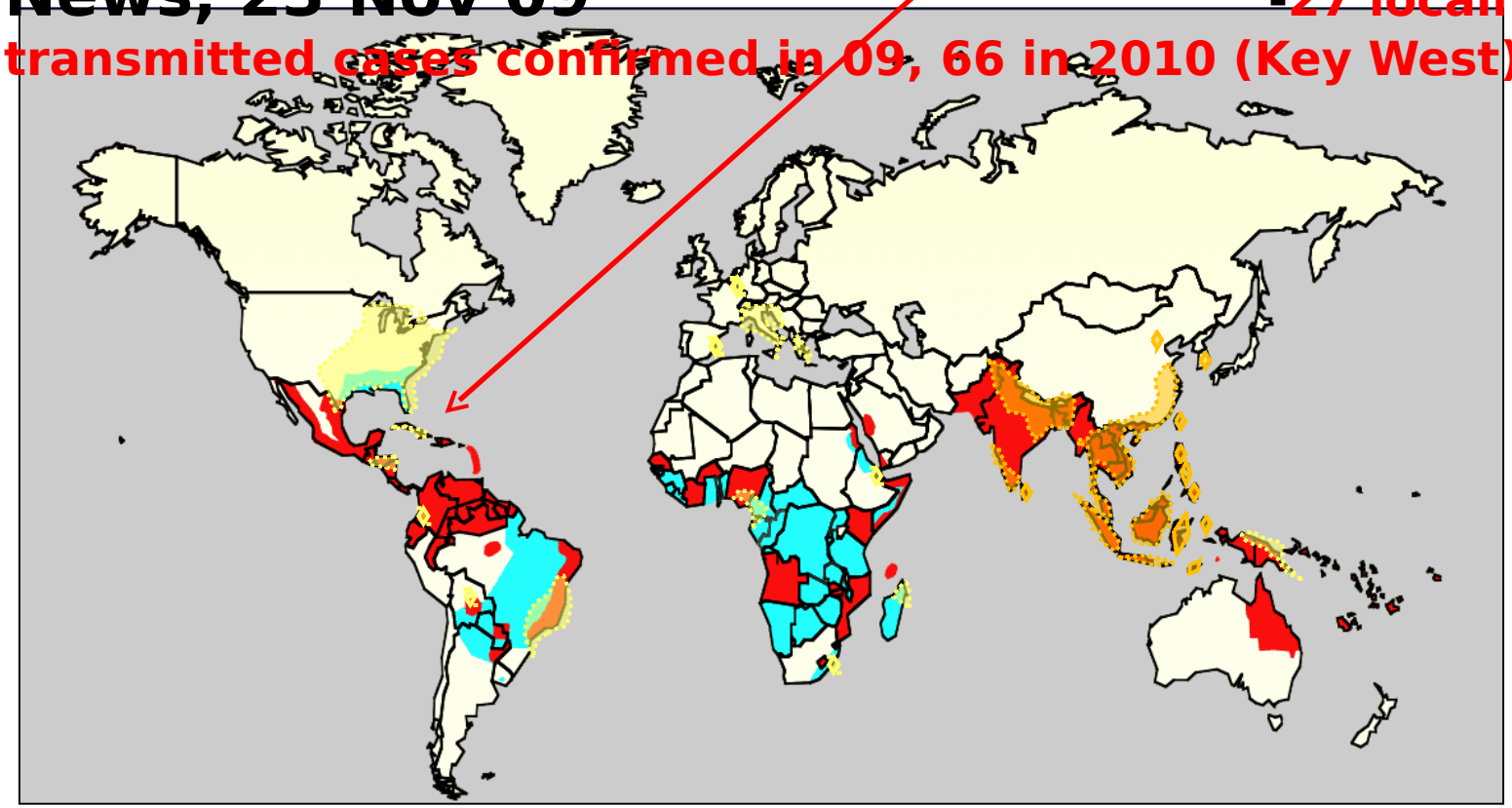
-First case of secondary transmission in Miami in 50 years in Nov 10; 2 cases in 2011
-First case of secondary transmission in Tampa diagnosed in Oct 2011

"Dengue virus returns to Florida after more than 50 years, UF researchers say" UF News, 23 Nov 09

-27 locally transmitted cases confirmed in 09, 66 in 2010 (Key West)

VECTOR INFLUENCE



Epidemic dengue:
Ae. aegypti distribution:
Ae. albopictus native range:
Ae. albopictus introduction since Dec 07:

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Feeding Habits – *Ae. albopictus*

- *Aedes albopictus* prefers to feed and rest outdoors.
- Feeds during daytime (diurnal)
- Feeds on any vertebrate host but prefers humans

Aedes comparison

	Ae. aegypti	*Ae. albopictus*
Environment	**Urban**	**Sylvatic***
Breed/feed	**Indoors(< 200m)**	**Outdoors**
Container type artificial	**Artificial**	**Natural and**
Biting peak	**Daytime**	**Dusk**
Host	**Human**	**Human/Vertebrates**

***Not necessarily**

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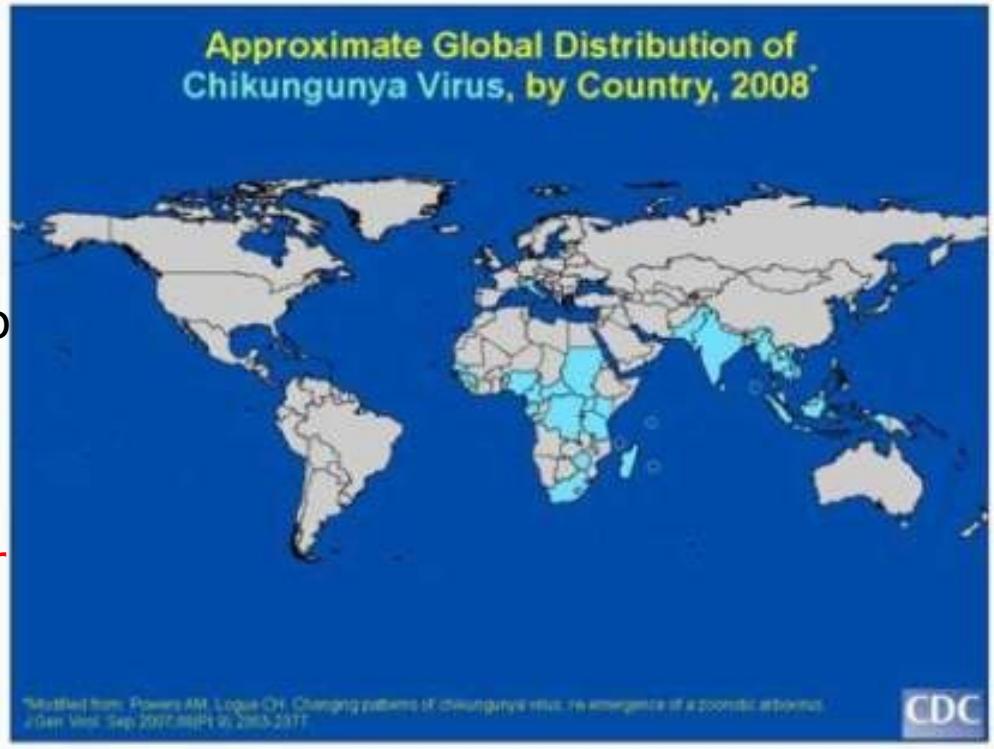
Chikungunya Fever

- Mosquito-borne virus
- Like dengue, traditional vector is *Ae. aegypti* but *Ae. albopictus* is competent vector; equivalent eradication challenges
- Symptomology also comparable to dengue
- Continuous outbreaks since 2005 in Europe, Asia & Africa, to include areas not previously endemic; over 200 cases in Italy in 2007
- Jun 11- Based on genomic studies from an outbreak of 480 cases in DRoC, *Ae. albopictus* is being considered as a more critical vector



•Over 1,100 cases Jan - April 2009 in Malaysia

• Outbreak ongoing in the Philippines Jul 2013- over 500 cases so far

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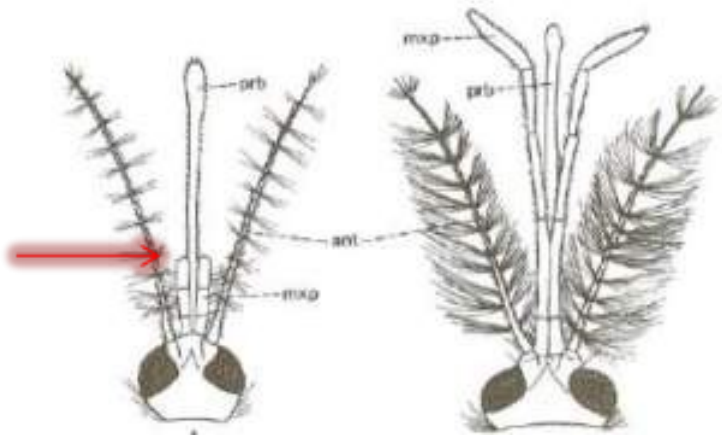
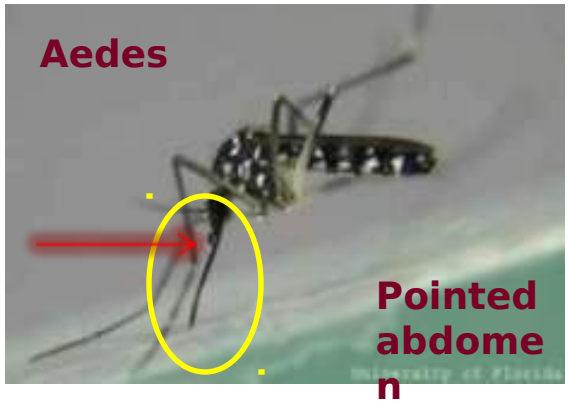
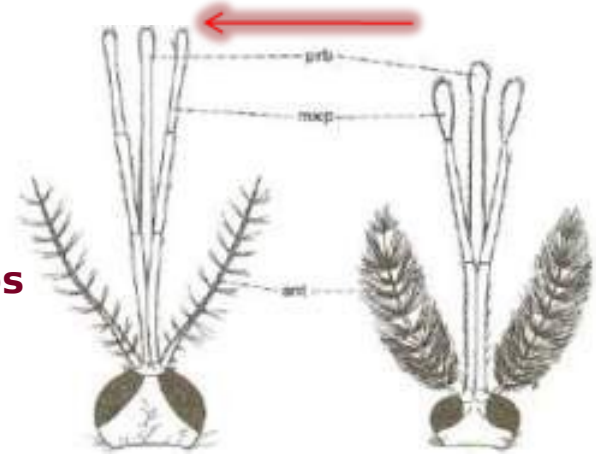
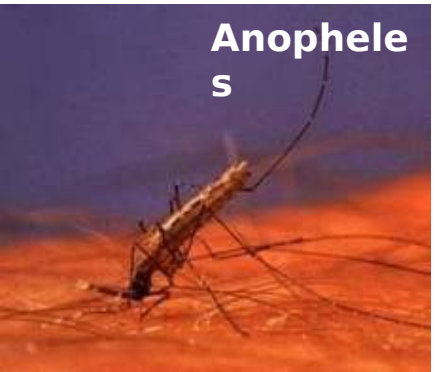
Mosquito Vectors (Culicidae)





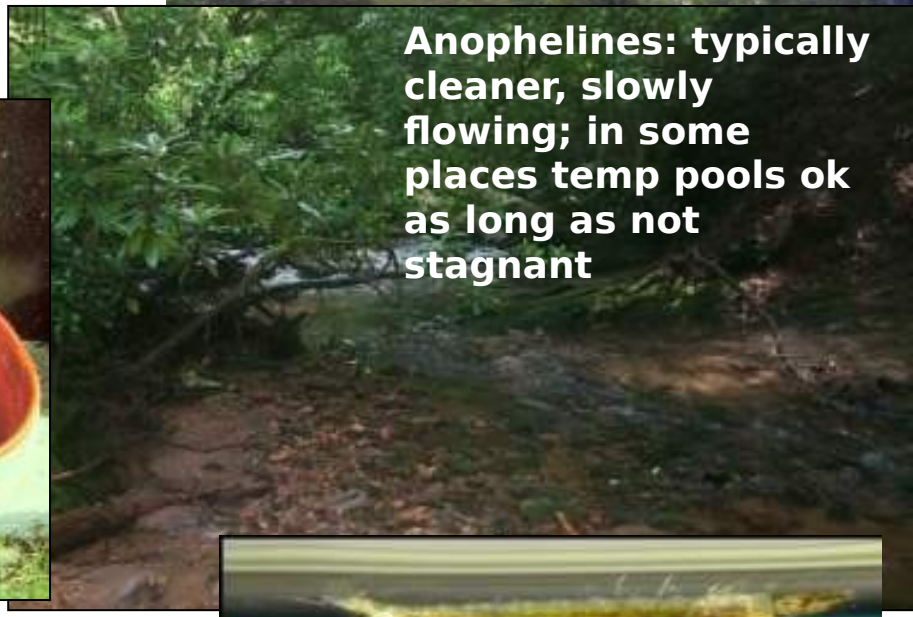


Length of palps compared to proboscis



Feeding behavior

Behavior & Habitat

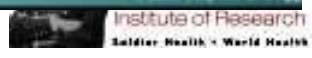


Anophelines: typically cleaner, slowly flowing; in some places temp pools ok as long as not stagnant

Aedes, Culex: stagnant, dirty, temp pools, opportunistic

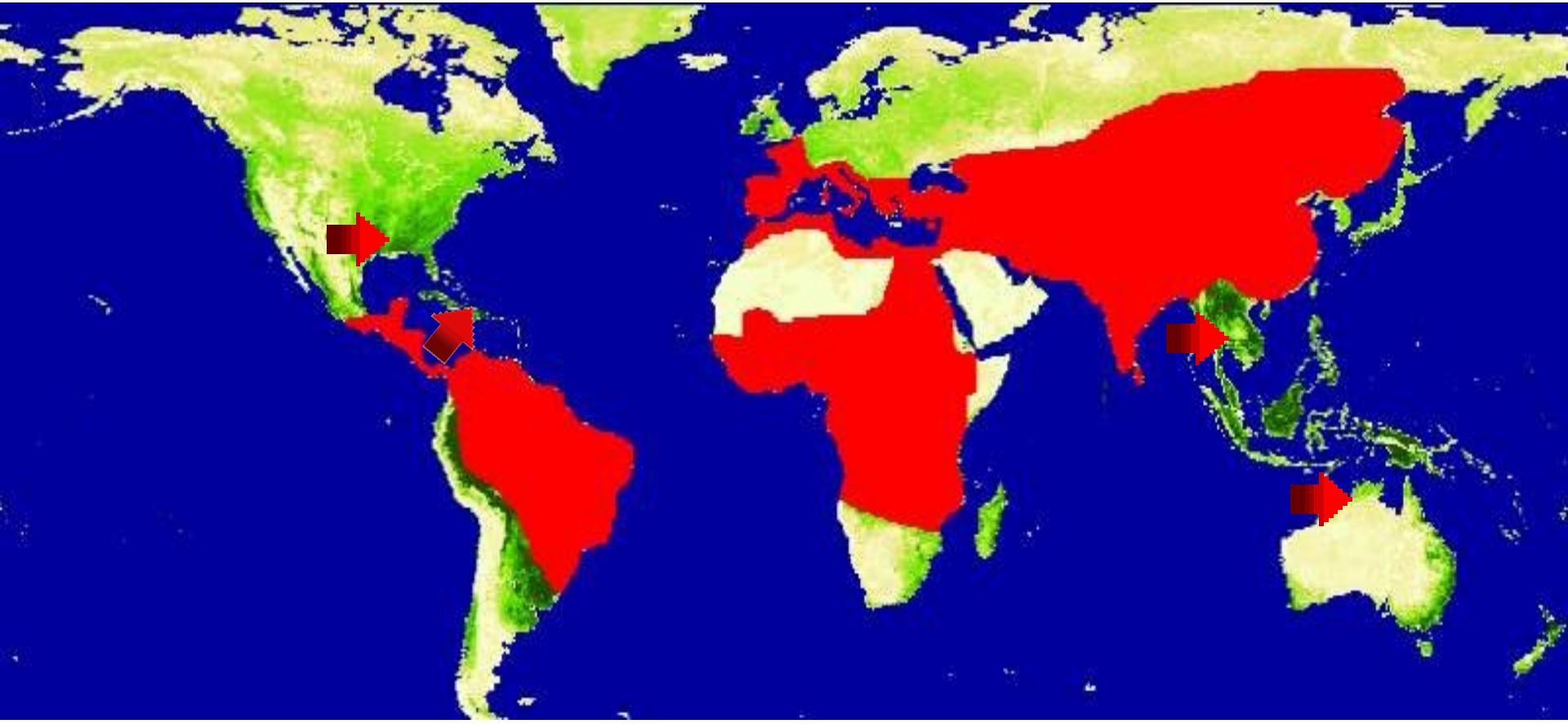
Aedes, Culex: body hangs down from the surface; uses

Anopheles: parallel to surface; spiracular plates on 8th abdominal segment



Sand Flies-

Global distribution of the leishmaniases (but not the global distribution of sand flies)



BITING BEHAVIOR

Mucocutaneous leish from French Guyana

The Epidemiological Triangle

Enzootic Cycle

Sand fly vector

Mammalian Reservoir home to the pathogen

Incidental Host

Man and his Activities

Psammomys obesus

Chenopods

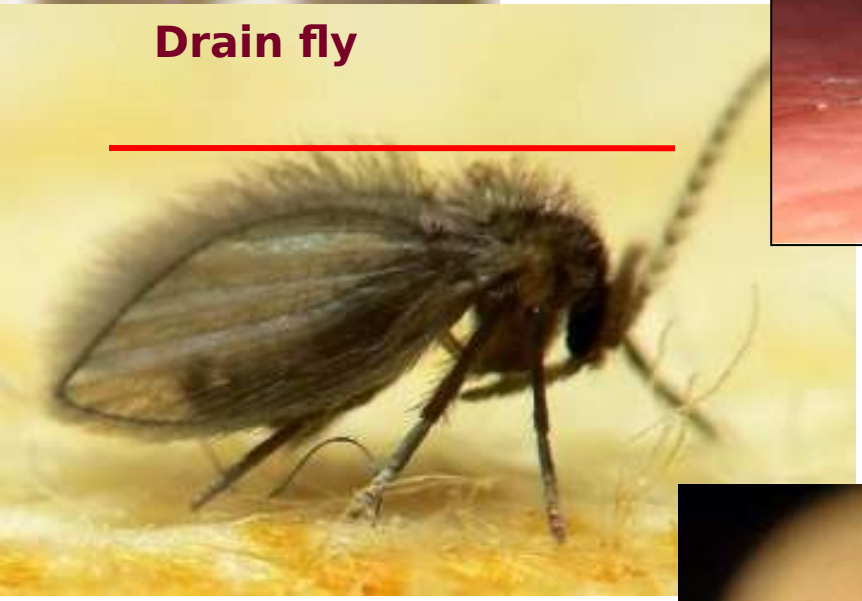
***L. major* enzootic cycle**

Characteristics

- Small (2-3 mm)
- Brown (but appear white when illuminated)
- Wings held in erect V-shape (even dead)
- Nocturnal
- Do not hover
- Silent
- Painful bite for some

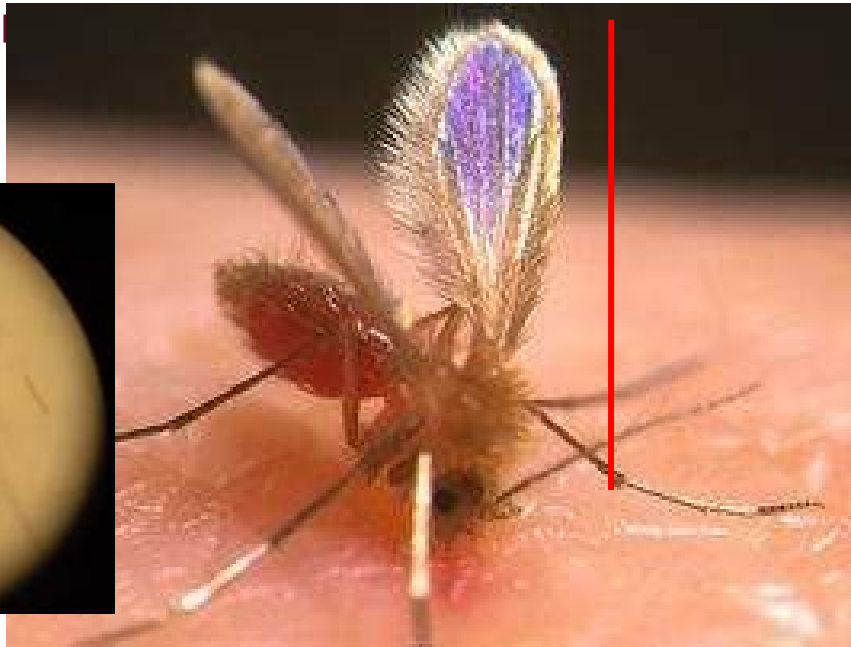
Psychodidae:
Leishmaniasis

Drain fly



Sand fly

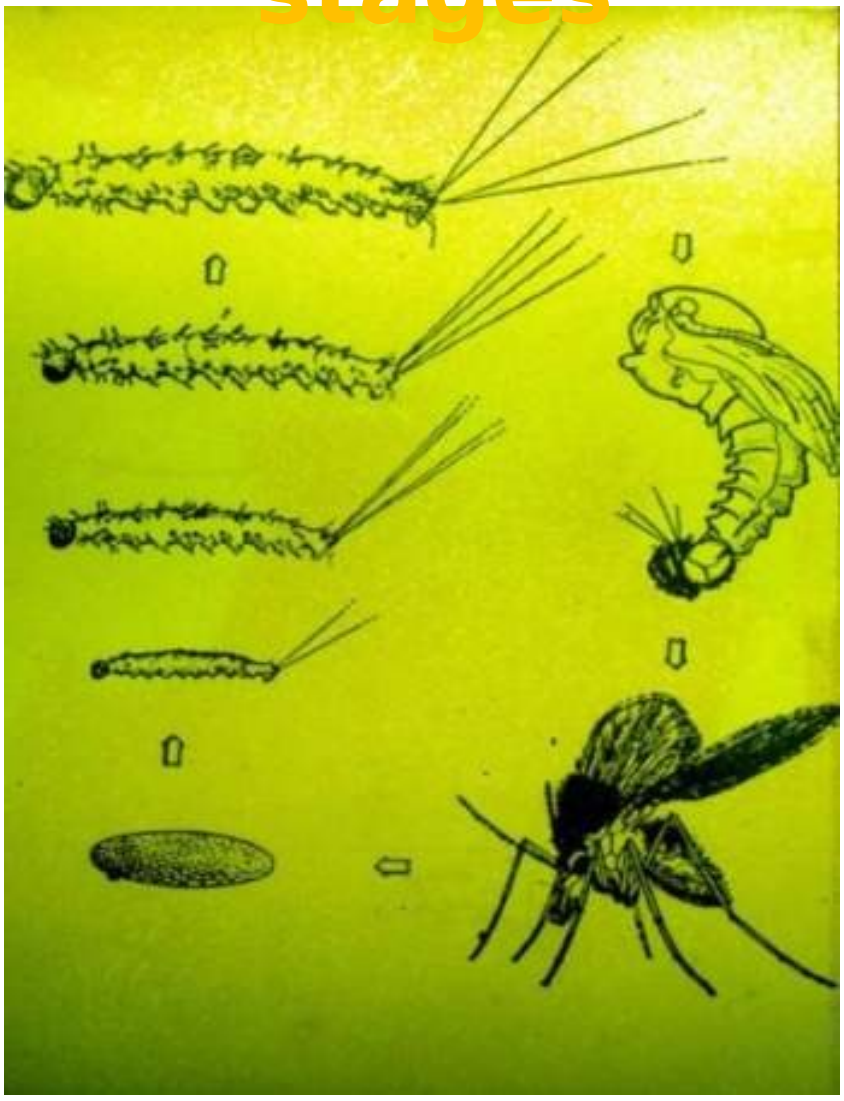
Phlebotomus (Old World) and Lutzomyia (New World) sp



Damp habitats, plumose antennae, larger, broader wings, more hair; sand fly always holds its wings up and away from its body, not flat like a drain fly

Life cycle and developmental stages

Fourth instar larvae



Life cycle

Adult male

Eggs

Adult female

Sand flies – vital requirements

- Larvae breed in soil (not aquatic)
- Only females take blood, from a variety of vertebrate species
- Rest during the day in dark, humid microhabitats
- Both sexes require sugar as an energy source

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Sand flies resting on wall of a chicken house

Variable Habitats:
rain forest, desert,





Tick-borne Diseases

African tick-bite fever (ATBF)

- an emerging infectious disease endemic in sub-Saharan Africa
- the most commonly encountered rickettsiosis in travel medicine.
- *Rickettisia africae*
- *Amblyomma variegatum*

1. Ndip et al., 2011. Risk Factors for African Tick-Bite Fever in Rural Central Africa. *Am. J. Trop. Med. Hyg.*

2. Raoult et al., 2001. *Rickettsia africae , a tick-borne pathogen in travelers* to sub-Saharan Africa . *N Engl J Med*

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Crimean Congo Hemorrhagic Fever

- **Sep 09: First US Soldier death from CCHF since WWII; acquired in AFG (Arghandab Valley)**
- Tick-borne virus (*Hyalomma*); 30% mortality rate
- **Can also be transmitted by exposure to fresh infected blood (human or animal)**
- Endemic in many countries in Africa, Europe, Asia and the Mediterranean; since 2001 cases or outbreaks have been recorded in Kosovo, Albania, Iran, Pakistan, and South Africa
- **Most widely distributed HF in the world**
- **Austere conditions ("the surge") increase the likelihood of transmission; fewer "tick checks", formal or informal**
- **Some success with ribivarin treatment; intensive monitoring of blood volume an uired**

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Tick Removal

U. S. Army Center for Health Promotion and Preventive Medicine

REMOVE TICKS PROMPTLY

If a tick is found attached to the body (Figure 1), seek assistance from medical authorities for proper removal, or follow these guidelines:

(1) **Grasp the tick's mouthparts** against the skin, using pointed tweezers (Figure 2).

(2) **Pull back** slowly and steadily with firm force.

(a) Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter (Figure 2).

(b) **BE PATIENT** – The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time-consuming (Figure 3, inset).

(c) Most ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh, further adding to the difficulty of removal.

(d) It is important to continue to pull steadily until the tick can be eased out of the skin (Figure 3).

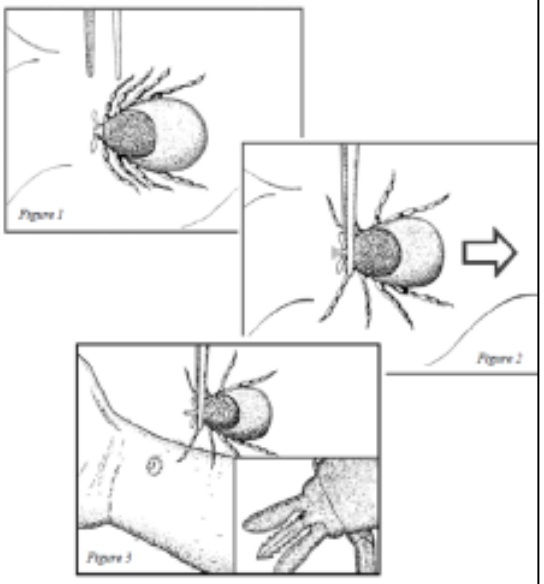
(e) **DO NOT** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, do not panic. Embedded mouthparts are comparable to having a splinter in your skin. Mouthparts alone cannot transmit disease because the infective body of the tick is no longer attached. However, to prevent the chance of secondary infection, it is best to remove them. Seek medical assistance if necessary.

(f) **DO NOT** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound site.

(g) **DO NOT** apply substances such as petroleum jelly, finger nail polish, finger nail polish remover, repellents, pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective, or worse, might agitate the tick and cause it to force more infective fluid into the wound site.

Following removal of the tick, wash the wound site (and your hands) with soap and water and apply an antiseptic.

Save the tick for future identification should you later develop disease symptoms. Preserve it by placing it in a clean, dry jar, vial, small Ziploc plastic bag, or other sealed container and keeping it in the freezer. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.



You may discard the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

A tick needs a blood meal from a host in order to molt (progress to the next stage of its life cycle), and to reproduce (lay eggs). This feeding process continues for several days to a week until the tick is fully engorged with blood. It then releases its hold on the host, drops off, and subsequently molts or lays eggs.

If the tick is infected with pathogenic organisms (for example, *Borrelia burgdorferi*, the agent of Lyme disease), it can transmit the infection to the host during the feeding process. As the tick feeds, the pathogens multiply, migrate to the tick's salivary glands, and are carried into the wound site along with the saliva.

Successful transmission of pathogens requires the tick to be attached for at least several hours. Therefore, the sooner infective ticks are removed, the less likely they will be able to transmit infection. It is impossible to tell if a tick is infected just by looking at it. Only analysis in a laboratory can determine infection status.

Entomological Sciences Program, Aberdeen Proving Ground, Maryland 21010-5403
October 2003

Chagas (American Trypanosomiasis)

Romana's Sign from fecal contamination

7 known US autochthonous cases in 2008

- Multiple modes of transmission: vector, oral, congenital, transfusion, organ transplant, food-borne
- Curative treatment only possible in acute phase; <1% diagnosed in that phase; chronic disease will shorten lifespan due to cardiac effects
- Zoonotic (dogs are also a host)- increases difficulty of eradication
- Transmission occurs in the US (Red Cross believes 300,000+ in US are infected)
- Increasing cases of food borne Chagas; ecological influences? mission impact? increased caution regarding local food sources? US transmission concerns?

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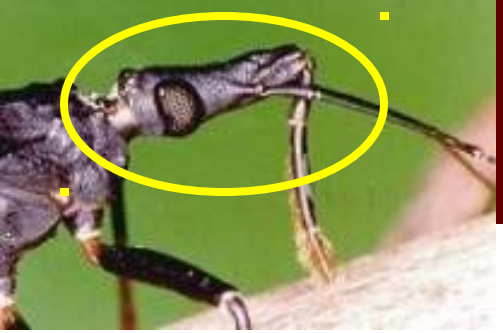
Reduviidae: Chagas



Kissing bugs

Triatoma infestans

Rhodnius Prolixus

Assassin bugs

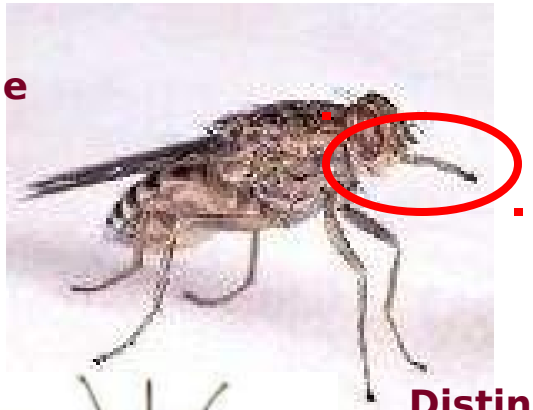
HAT and Naga

Over 50% of the landcover in Africa is considered "highly suitable" to the tsetse fly

Glossinidae: African

Muscidae sp.

Glossinidae sp.



Distinct features: long proboscis, calyptrate attenae, ptilinal suture, the wings overlap completely when held over the abdomen, the discal medial (i.e. the middle) cell of the wing has a characteristic hatchet shape; and it has

Prevention

WHAT CAN YOU DO TO MINIMIZE RISK?

- Find out what the priority risks are in your area before you deploy.
- Understand the vectors so you can avoid them.
- Modify behaviors to minimize contact
  - Use **repellents**
  - Sleep under insecticide treated netting
  - Wear permethrin treated uniforms
- Take malaria chemo (if warranted)
- Call for help:
  - AFPMB (CLO) : afpmb-webmaster@osd.mil: subject CLO question
  - PHC, Ento Division

Standard Military DEET Skin Repellent

Commercial

Military

33% Controlled-Release DEET Lotion: NSN 6840-01-284-3982

Highest rated skin repellent available (Consumer Reports, May 2003)

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CDC recommended repellents

- Of the active ingredients registered with the EPA, products containing these active ingredients typically provide longer-lasting protection than others:

DEET, Picaridin, and IR3535

- The three non-DEET compounds work as well as or nearly as well as DEET when they are used at higher concentrations (~20%).

http://www.cdc.gov/ncidod/dvbid/westnile/repellentupdates.htm

http://www.epa.gov/pesticides/health/mosquitoes/ai_insectrp.htm

http://www.entomology.wisc.edu/mosquitosite/topicalrepel.html

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Picaridin

- Picaridin is a colorless, nearly odorless liquid active ingredient that is recommended by the CDC as an alternative to DEET.
- Lab and field studies of products containing picaridin (10-20%) indicate good protection.
- 7.5% products are not as effective.

- Natrapel, 20%, 3.5-oz. Pump Spray
- Cutter Advanced, 7%, 6-oz. Pump Spray
- Off Skintastic, 5%, 6-oz. Pump Spray

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IR3535

- IR3535 is recommended by the CDC as an alternative to DEET.
- IR3535 is a synthetic insect repellent structurally similar to a natural amino acid, beta-alanine and is classified as a biopesticide by the EPA.
- This compound has been used as a mosquito repellent in Europe and Asia for 10-20 years
- Approved by the U.S. EPA in 1999.
- IR3535 is currently available in the Avon Skin-so-soft Bug Guard 7.5%

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Treated Uniforms

- A new training briefing on permethrin-treated Flame-Resistant Army Combat Uniforms (FR ACUs) has been released –CAC REQUIRED
- https://www.us.army.mil/suite/doc/28282876
- https://peosoldier.army.mil/newpeo/ContactUs/faqs/fracu.asp

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Bed nets

Enhanced BedNet System 3740-01-546-4354

Improved Bed Net System 3740-01-543-5652

Bed net, Pop-up, self-supporting

Coyote Brown 3740-01-518-7310

OD Green (Camo) 3740-01-516-4415

NSN 3740-01-518-7310-CL 0X Item, must be ordered through CL IX SARSS

The pop-up bed net is factory-treated with permethrin and has much finer mesh than the standard military bed net.

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Myth Busters

- No evidence that eating garlic or taking vitamin B tablets reduces mosquito bites.
- Dark clothing is usually more attractive than light colored clothing.
- Drinking alcohol may increase your attractiveness to mosquitoes.

Myth Busters

- Some mosquito control devices use repellents to protect a small outdoor area like a patio.
- No products approved by the EPA for indoors.
- Effective devices which use **allethrin** or other **pyrethroids** to repel mosquitoes include:
  - Mosquito coils, and
  - ThermaCell (TM) Mosquito Repellent System.

Myth Busters

Myth Busters

- Citronella candles are weak.
- Geraniol candles can provide 1 meter of protection.

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Myth Busters

- Sonic and electronic devices do not work.

References/Resources (1 of 2)

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- Knowlton, K., Solomon, G. and M. Rotkin-Ellman. Mosquito-Borne Dengue Fever Threat Spreading in the Americas. NRDC Issue Paper. July 2009.
- WRAIR 1367 Project 002. USASOC Dengue Seroprevalence Protocol. 10 Sep 09.
- http://www.promedmail.org/
- Evaluation of SD BIOLINE Chagas Ab Rapid kit. Korean J Lab Med. 2009 Feb;29(1):48-52.
- www.gideononline.com
- http://www.plosntds.org/article/slideshow.action?uri=info:doi/10.1371/journal.pntd.0000196&imageURI=info:doi/10.1371/journal.pntd.0000196.g001 for dengue algorithm.

More Resources (2 of 2)

- ASTMH Intensive Short Course, Annual Pre-Meeting Course and Conference 2009, 2010, 2011. www.astmh.org
- http://www.cdc.gov/eid/content/14/5/pdfs/814.pdf for *P. knowlesi* article.
- Field Guide to Medically Important Invertebrates Affecting Military Operations. Jun 2006.
- http://www.afpmb.org/pubs/Field_Guide/field_guide.htm
- Medical Entomology: An Ecological Perspective. G.A.H. McClelland. 12th Edition. 1992.
- An Introduction to the Study of Insects. Borror, Triplehorn, Johnson. 12th Edition.
- Tsetse fly habitat and land cover: an analysis at continental level. ftp://ftp.fao.org/docrep/fao/010/i0215e/i0215e01.pdf
- The Social Ecology of Infectious Diseases. Mayer and Pizer. 1st Edition. 2008.

Questions?

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